

**CLAIMS**

1. A partially cured reinforced polymeric article which includes one or more layers, each layer including:
  - a reinforcing web;
  - 5 a partially cured cross-linkable polymeric composition being formed from:
    - an ultra-violet (UV) curable polymeric resin; and
    - a photoinitiator; or
    - a photoinitiator and a thermal initiator
- 10 wherein the polymeric resin and photoinitiator are selected to permit formation of the partially cured cross-linkable polymeric composition in less than approximately 120 seconds.
2. A polymeric article according to claim 1 wherein the partially cured cross-linkable polymeric composition is formed in approximately 5 to 60 seconds.
- 15 3. A polymeric article according to claim 2 wherein the partially cured cross-linkable polymeric composition is formed in approximately 10 to 45 seconds.
4. A polymeric article according to any one of claims 1 to 3 wherein there are two or more layers and the layers are of substantially the same thickness.
- 20 5. A polymeric article according to any one of claims 1 to 3 wherein there are two or more layers and one or more of the layers is of a differing thickness from one other layer in the article.
6. A polymeric article according to any one of claims 1 to 5 wherein there are two or more layers and one or more of the layers includes a reinforcing web of differing material from the material of one other layer in the article.

7. A polymeric article according to any one of claims 1 to 6 wherein the cross-linkable polymeric composition is present in an amount between approximately 10 and 90% by weight.

8. A polymeric article according to claim 7 wherein the cross linkable  
5 polymeric composition is present in an amount between approximately 25 and 75% by weight.

9. A polymeric article according to claim 8 wherein the cross linkable polymeric composition is present in an amount between approximately 35 and 65% by weight.

10 10. A polymeric article according to any one of claims 1 to 9 wherein the article has a weight of from approximately 20 to 2000 g/m<sup>2</sup>.

11. A polymeric article according to claim 10 wherein the article has a weight of from approximately 100 to 1500 g/m<sup>2</sup>.

12. A polymeric article according to claim 11 wherein the article has a  
15 weight of from approximately 500 to 1000 g/m<sup>2</sup>.

13. A polymeric article according to any one of claims 1 to 12 wherein the reinforcing web is selected from one or more of the group consisting of glass fibres; carbon and graphite fibres, polymeric fibres, boron filaments, ceramic fibres, metal fibres, asbestos fibres, beryllium fibres, silica fibres and silicon  
20 carbide fibres.

14. A polymeric article according to claim 13 wherein the glass fibres are in the form of fibreglass sheets or matts.

15. A polymeric article according to any one of claims 1 to 14 wherein the UV curable polymeric resin is selected from the group consisting of a curable  
25 polyester, a vinyl ester resin, a epoxy vinyl ester resin and a bisphenol- A epoxy resin.

16. A polymeric article according to any one of claims 1 to 15 wherein the photoinitiator is present in an amount of from 0.01% to 5% by weight.

17. A polymeric article according to claim 16 wherein the photoinitiator is present in an amount of from 0.1% to 0.2% by weight.

5 18. A polymeric article according to anyone of claims 1 to 17 wherein the photoinitiator is selected from the group consisting of Ciba Geigy Irgacure 819, Ciba Geigy Irgacure184 (1-hydroxy cyclohexyl phenyl ketone), Ciba Geigy Irgacure 654 (benzildimethyl ketal), Ciba Geigy Irgacure 907 (2-methyl-1-{4-(methylthio)phenyl}-2-morpholino-propanone-1), Merck Darocur 1664, Rohm 10 Catalyst 22, Alcolac Vicure 10 (isobutyl benzoin ether), Alcolac Vicure 30 (isobutyl benzoin ether), and Alcolac Vicure 55 (55) (methyl phenyl glyoxylate phenyl ketone).

19. A polymeric article according to any one of claims 1 to 18 wherein the thermal initiator, if present, is selected from the group consisting of peroxides, 15 1,1-di-*tert*-butyl peroxy-3,3,5-trimethylcyclohexane, and *sec*-isopropyl percarbonate or a combination thereof.

20. A polymeric article according to any one of claims 1 to 19, wherein the cross-linkable polymeric composition further includes an additive or modifier selected from the group consisting of inhibitors, UV stabilisers, UV absorbers, 20 antioxidants, tinting agents, transfer agents, viscosity modifiers, adhesion promoters/modifiers, colourants, fire resistance agents, antistatic agents, fillers, heat stabilisers, thixotropic agents, slip and blocking agents, and air release agents or a combination thereof.

21. A process for preparing a partially cured reinforced polymeric article 25 including:

providing one or more layers, each layer including:

a reinforcing web; and

an effective amount of a cross-linkable polymeric composition including:

- a UV curable polymeric resin and
- a photoinitiator; or
- 5 a photoinitiator and a thermal catalyst;

impregnating the reinforcing web with the cross-linkable polymeric composition; and

10 exposing the impregnated web to a source of ultraviolet (UV) radiation for a period of less than approximately 120 seconds, at an intensity sufficient to partially cure the resin.

22. A process according to claim 21 wherein the impregnated web is exposed to ultraviolet (UV) radiation for a period of from approximately 5 to 60 seconds.

23. A process according to claim 22 wherein the impregnated web is 15 exposed to ultraviolet (UV) radiation for a period of from 10 to 45 seconds.

24. A process according to any one of claims 21 to 23 wherein the intensity of the ultraviolet (UV) radiation is from approximately  $1 \times 10^{-5}$  to  $10 \times 10^{-7}$  W/cm<sup>2</sup>.

25. A process according to claim 24 wherein the intensity of the 20 ultraviolet (UV) radiation is from approximately  $5 \times 10^{-5}$  and  $5 \times 10^{-6}$  W/cm<sup>2</sup>.

26. A process according to any one of claims 21 to 25 wherein the polymeric article includes two or more layers, and the layers are of substantially the same thickness.

27. A process according to any one of claims 21 to 25 wherein the 25 polymeric article includes two or more layers, and one or more of the layers is of differing thickness from one other layer in the article.

28. A process according to any one of claims 21 to 27 wherein the polymeric article includes two or more layers, and one or more of the layers includes a reinforcing web of differing material from the material of one other layer in the article.
- 5 29. A process according to any one of claims 21 to 25 wherein the reinforcing web is selected from one or more of the group consisting of glass fibres; carbon and graphite fibres, polymeric fibres, boron filaments, ceramic fibres, metal fibres, asbestos fibres, beryllium fibres, silica fibres and silicon carbide fibres.
- 10 30. A process according to claim 29 wherein the glass fibres are in the form of fibreglass sheets or matts.
31. A process according to any one of claims 21 to 30 wherein the UV curable polymeric resin is selected from the group consisting of a curable polyester, a vinyl ester resin, a epoxy vinyl ester resin and a bisphenol- A epoxy resin.
- 15 32. A process according to any one of claims 21 to 31 wherein the photoinitiator is present in an amount of from 0.01% to 5% by weight.
33. A process according to claim 32 wherein the photoinitiator is present in an amount of from 0.1% to 0.2% by weight.
- 20 34. A process according to any one of claims 21 to 33 wherein the photoinitiator is selected from the group consisting of Ciba Geigy Irgacure 819, Ciba Geigy Irgacure184 (1-hydroxy cyclohexyl phenyl ketone), Ciba Geigy Irgacure 654 (benzildimethyl ketal), Ciba Geigy Irgacure 907 (2-methyl-1-{4-(methylthio)phenyl}-2-morpholino-propanone-1), Merck Darocur 1664, Rohm 25 Catalyst 22, Alcolac Vicure 10 (isobutyl benzoin ether), Alcolac Vicure 30 (isobutyl benzoin ether), and Alcolac Vicure 55 (55) (methyl phenyl glyoxylate phenyl ketone).

35. A process according to any one of claims 21 to 34 wherein the thermal initiator, if present, is selected from the group consisting of peroxides, 1,1-di-*tert*-butyl peroxy-3,3,5-trimethylcyclohexane, and *sec*-isopropyl percarbonate or a combination thereof.
- 5 36. A process according to any one of claims 21 to 35 wherein the cross-linkable polymeric composition further includes an additive or modifier selected from the group consisting of inhibitors, UV stabilisers, UV absorbers, antioxidants, tinting agents, transfer agents, viscosity modifiers, adhesion promoters/modifiers, colourants, fire resistance agents, antistatic agents, fillers, heat stabilisers, 10 thixotropic agents, slip and blocking agents, and air release agents or a combination thereof.
37. A laminate polymeric article including:
- a partially cured reinforced polymeric article which includes one or more layers, each layer including:
- 15      a reinforcing web;
- a partially cured cross-linkable polymeric composition formed from:
- an ultraviolet (UV) curable polymeric resin; and
- a photoinitiator; or
- a photoinitiator and a thermal initiator;
- 20      wherein the polymeric resin and the photoinitiator are selected to permit formation of the partially cured cross-linkable polymeric composition in less than approximately 120 seconds; and
- a first protective coating or film overlaying at least a portion of a surface of the reinforced polymeric article.
- 25 38. A laminate polymeric article according to claim 37 wherein the partially cured cross-linkable polymeric composition is formed in approximately 5 to 60 seconds.

39. A laminate polymeric article according to claim 38 wherein the partially cured cross-linkable polymeric composition is formed in approximately 10 to 45 seconds.

40. A laminate polymeric article according to any one of claims 37 to 39 5 wherein there are two or more layers and the layers are of substantially the same thickness.

41. A laminate polymeric article according to any one of claims 37 to 39 wherein there are two or more layers and one or more of the layers is of a differing thickness from one other layer in the article.

10 42. A laminate polymeric article according to any one of claims 37 to 41 wherein there are two or more layers and one or more of the layers includes a reinforcing web of differing material from the material of one other layer in the article.

15 43. A laminate polymeric article according to any one of claims 37 to 42 wherein the cross-linkable polymeric composition is present in an amount between approximately 10 and 90% by weight.

44. A laminate polymeric article according to claim 43 wherein the cross linkable polymeric composition is present in an amount between approximately 25 and 75% by weight.

20 45. A laminate polymeric article according to claim 44 wherein the cross linkable polymeric composition is present in an amount between approximately 35 and 65% by weight.

46. A laminate polymeric article according to any one of claims 1 to 45 wherein the article has a weight of from approximately 20 to 2000 g/m<sup>2</sup>.

25 47. A laminate polymeric article according to claim 46 wherein the article has a weight of from approximately 100 to 1500 g/m<sup>2</sup>.

48. A laminate polymeric article according to claim 47 wherein the article has a weight of from approximately 500 to 1000 g/m<sup>2</sup>.

49. A laminate polymeric article according to any one of claims 37 to 48 wherein the partially cured reinforced polymeric article includes two or more layers 5 and the layers are of substantially the same thickness.

50. A laminate polymeric article according to any one of claims 37 to 48 wherein the partially cured reinforced polymeric article includes two or more layers and one or more layers is of differing thickness from one other layer in the article.

51. A laminate polymeric article according to any one of claims 37 to 50 10 wherein the partially cured reinforced polymeric article includes two or more layers and one or more layers includes a reinforcing web of differing material from the material of one other layer in the article.

52. A laminate polymeric article according to any one of claims 37 to 51 15 wherein the protective coating or layer is applied to one major surface of the polymeric article.

53. A laminate polymeric article according to any one of claims 37 to 51 wherein the protective coating or layer is applied to both major surfaces of the polymeric article.

54. A laminate polymeric article according to any one of claims 37 to 53 20 wherein the first protective coating or film is a polymeric film or sheet.

55. A laminate polymeric article according to claim 54 wherein the polymeric film or sheet is a thermoplastic polymeric film.

56. A laminate polymeric article according to claim 55 wherein the thermoplastic polymeric film is selected from the group consisting of polyethylene, 25 polypropylene or nylon film.

57. A laminate polymeric article according to any one of claims 37 to 56 wherein the first protective coating or film is UV opaque.

58. A laminate polymeric article according to any one of claims 37 to 57 further including a UV opaque outer coating overlaying, at least in part, an 5 exposed surface of the partially cured reinforced polymeric article or first protective coating or film.

59. A laminate polymeric article according to claim 58 wherein the UV opaque outer coating is a metal foil.

60. A laminate polymeric article according to any one of claims 37 to 59 10 wherein the reinforcing web is selected from one or more of the group consisting of glass fibres; carbon and graphite fibres, polymeric fibres, boron filaments, ceramic fibres, metal fibres, asbestos fibres, beryllium fibres, silica fibres and silicon carbide fibres.

61. A laminate polymeric article according to claim 60 wherein the glass 15 fibres are in the form of fibreglass sheets or matts.

62. A laminate polymeric article according to any one of claims 37 to 61 wherein the UV curable polymeric resin is selected from the group consisting of a curable polyester, a vinyl ester resin, a epoxy vinyl ester resin and a bisphenol- A epoxy resin.

20 63. A laminate polymeric article according to any one of claims 37 to 62 wherein the photoinitiator is present in an amount of from 0.01% to 5% by weight.

64. A laminate polymeric article according to claim 63 wherein the photoinitiator is present in an amount of from 0.1% to 0.2% by weight.

65. A laminate polymeric article according to any one of claims 37 to 64 25 wherein photoinitiator is selected from the group consisting of Ciba Geigy Irgacure 819, Ciba Geigy Irgacure184 (1-hydroxy cyclohexyl phenyl ketone), Ciba Geigy Irgacure 654 (benzildimethyl ketal), Ciba Geigy Irgacure 907 (2-methyl-1-(4-

(methylthio)phenyl)-2-morpholino-propanone-1), Merck Darocur 1664, Rohm Catalyst 22, Alcolac Vicure 10 (isobutyl benzoin ether), Alcolac Vicure 30 (isobutyl benzoin ether), and Alcolac Vicure 55 (55) (methyl phenyl glyoxylate phenyl ketone).

5 66. A laminate polymeric article according to any one of claims 37 to 65 wherein the thermal initiator, if present, is selected from the group consisting of peroxides, 1,1-di-*tert*-butyl peroxy-3,3,5-trimethylcyclohexane, and *sec*-isopropyl percarbonate or a combination thereof.

67. A laminate polymeric article according to any one of claims 37 to 66  
10 wherein the cross-linkable polymeric composition further includes an additive or modifier selected from the group consisting of inhibitors, UV stabilisers, UV absorbers, antioxidants, tinting agents, transfer agents, viscosity modifiers, adhesion promoters/modifiers, colourants, fire resistance agents, antistatic agents, fillers, heat stabilisers, thixotropic agents, slip and blocking agents, and air release  
15 agents or a combination thereof.

68. A process of forming a shaped article including:  
shaping one or more partially cured reinforced polymeric articles which include one or more layers, each layer including:  
a reinforcing web;  
20 a partially cured cross-linkable polymeric composition formed from:  
an ultraviolet (UV) curable polymeric resin; and  
a photoinitiator; or  
a photoinitiator and a thermal initiator;

25 wherein the polymeric resin and the photoinitiator are selected to permit formation of the partially cured cross-linkable polymeric composition in less than approximately 120 seconds;

shaping one or more partially cured reinforced polymeric articles into a desired form; and

subjecting the formed article to a final curing step.

69. A process according to claim 68 wherein the partially cured cross-linkable polymeric composition is formed in approximately 5 to 60 seconds.

70. A process according to claim 69 wherein the partially cured cross-linkable polymeric composition is formed in approximately 10 to 45 seconds.

71. A process according to any one of claims 68 to 70 wherein the partially cured reinforced polymeric article includes two or more layers and the 10 layers are of substantially the same thickness.

72. A process according to any one of claims 68 to 70 wherein the partially cured reinforced polymeric article includes two or more layers and one or more layers is of differing thickness from one other layer in the article.

73. A process according to any one of claims 68 to 72 wherein the 15 partially cured reinforced polymeric article includes two or more layers and one or more layers includes a reinforcing web of differing material from the material of one other layer in the article.

74. A process according to any one of claims 68 to 73 wherein the final curing step includes exposing the formed article to UV radiation.

75. A process according to any one of claims 68 to 74 wherein the final curing step includes a method involving applying heat and pressure to the formed articles.

76. A process according to claim 74 wherein the UV radiation has an intensity of from approximately  $1 \times 10^{-4}$  to  $1 \times 10^{-6}$  W/cm<sup>2</sup>.

77. A process according to claim 76 wherein the UV radiation has an intensity of from approximately  $5 \times 10^{-4}$  and  $5 \times 10^{-5}$  W/cm<sup>2</sup>.

78. A process according to any one of claims 74 to 77 wherein the formed article is exposed to UV radiation for a period of from approximately 0.5 to 120 minutes.

79. A process according to claim 78 wherein the formed article is exposed to UV radiation for a period of from approximately 10 to 45 minutes.

80. A process according to claim 74 wherein the final curing step includes subjecting the formed article to a thermal curing.

81. A process according to claim 80 wherein the temperature of the thermal curing is between approximately 50 and 150°C.

82. A process according to claim 81 wherein the temperature of the thermal curing is between approximately 65 and 100°C.

83. A process according to claim 75 wherein the pressure applied during the final cure is between approximately 30 and 100 psi.

84. A process according to claim 83 wherein the pressure applied during the final cure is between approximately 50 and 70 psi.

85. A process according to any one of claims 68 to 84 wherein the reinforcing web is selected from one or more of the group consisting of glass fibres; carbon and graphite fibres, polymeric fibres, boron filaments, ceramic fibres, metal fibres, asbestos fibres, beryllium fibres, silica fibres and silicon carbide fibres.

86. A process according to claim 85 wherein the glass fibres are in the form of fibreglass sheets or matts.

87. A process according to any one of claims 68 to 86 wherein the UV curable polymeric resin is selected from the group consisting of a curable polyester, a vinyl ester resin, a epoxy vinyl ester resin and a bisphenol- A epoxy resin.

88. A process according to any one of claims 68 to 87 wherein the photoinitiator is present in an amount of from 0.01% to 5% by weight.

89. A process according to claim 88 wherein the photoinitiator is present in an amount of from 0.1% to 0.2% by weight.

5        90. A process according to any one of claims 68 to 89 wherein the photoinitiator is selected from the group consisting of Ciba Geigy Irgacure 819, Ciba Geigy Irgacure184 (1-hydroxy cyclohexyl phenyl ketone), Ciba Geigy Irgacure 654 (benzildimethyl ketal), Ciba Geigy Irgacure 907 (2-methyl-1-{4-(methylthio)phenyl}-2-morpholino-propanone-1), Merck Darocur 1664, Rohm 10 Catalyst 22, Alcolac Vicure 10 (isobutyl benzoin ether), Alcolac Vicure 30 (isobutyl benzoin ether), and Alcolac Vicure 55 (55) (methyl phenyl glyoxylate phenyl ketone).

15        91. A process according to any one of claims 68 to 90 wherein the thermal initiator, if present, is selected from the group consisting of peroxides, 1,1-di-*tert*-butyl peroxy-3,3,5-trimethylcyclohexane, and *sec*-isopropyl percarbonate or a combination thereof.

20        92. A process according to any one of claims 68 to 91 wherein the cross-linkable polymeric composition further includes an additive or modifier selected from the group consisting of inhibitors, UV stabilisers, UV absorbers, antioxidants, tinting agents, transfer agents, viscosity modifiers, adhesion promoters/modifiers, colourants, fire resistance agents, antistatic agents, fillers, heat stabilisers, thixotropic agents, slip and blocking agents, and air release agents or a combination thereof.

25        93. A cured shaped article formed by a process according to any one of claims 68 to 92.